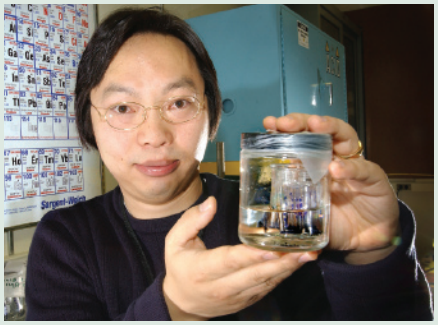
Developing a Safer Way to Make One Class of Superconductors

A scientist at Brookhaven National Laboratory has developed a safer, more environmentally friendly way to create an experimental superconductor. This new process facilitates the study of superconductors, which are used in medical imaging machines and are expected to improve computer chips, electrical transmission lines, and many other devices. The findings appeared in the November 19, 2003, issue of *Physical Review B*.

Previously, creating the superconductor, called sodium cobalt oxyhydrate, required working with volatile and flammable liquids and created chemical waste. Now, BNL chemist Sangmoon Park has devised a cleaner synthesis method using plain water. Park works in the Physics Department's Materials Synthesis and Characterization group with his advisor, physicist Tom Vogt.

"We prepared the superconductor using an alternate route that does not require the special precautions necessary to handle hazardous substances," said Park. "Also, this method allows us to synthesize large amounts of the material, which will make it easier for us to further analyze its properties."

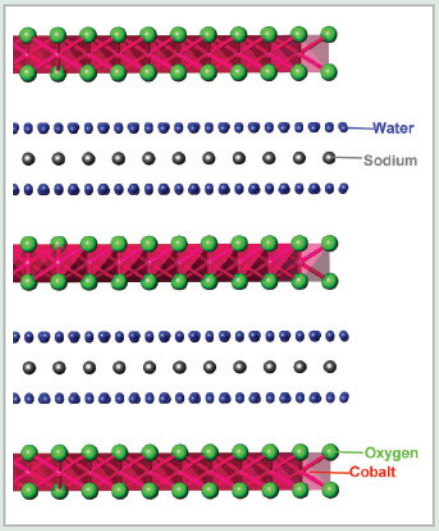


Sangmoon Park holds a sample of a superconducting compound.

Unlike metal-based superconductors, sodium cobalt oxyhydrate contains water. In 2003 researchers discovered that adding water to the initial cobalt-oxygen compound, called cobalt oxide, induced its superconductivity. This discovery, coupled with Park's method, may open a door to new superconductor research.

To synthesize the superconductor, Park dissolved a sodium/sulfur/oxygen compound into water, which caused sodium ions and sodium/oxygen (sulfate) ions to separate from it. This solution was mixed with a sodium/cobalt/oxygen compound. The resulting no-waste reaction created the superconductor. The material's structure and the amounts of its components, particularly the sodium and water, impart its superconducting properties. This was confirmed by measurements performed by chemist Arnold Moodenbaugh in the Materials Science Department.

The superconductor consists of hexagon-shaped layers: Cobalt oxide forms one layer and the sodium and water, together, form another – like a stack of pancakes and waffles, with each pair of thin cobalt oxide "pancakes" separated by a thick sodium/water "waffle." After surrounding it with an alcohol/water mixture, the material was subjected to pressure that distorted the layers by forcing alcohol or water molecules between them. This may further alter the material's behavior.



A cross-section representation of the superconductor's layer structure.

This distortion was studied using x-ray diffraction at NSLS beamline X7A by Yongjae Lee of the Materials Synthesis and Characterization Group. This revealed that, even at very low pressures, the superconductor's structure changed significantly. Park and his colleagues plan to investigate how these changes affect its superconductivity.

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—Laura Mgrdichian